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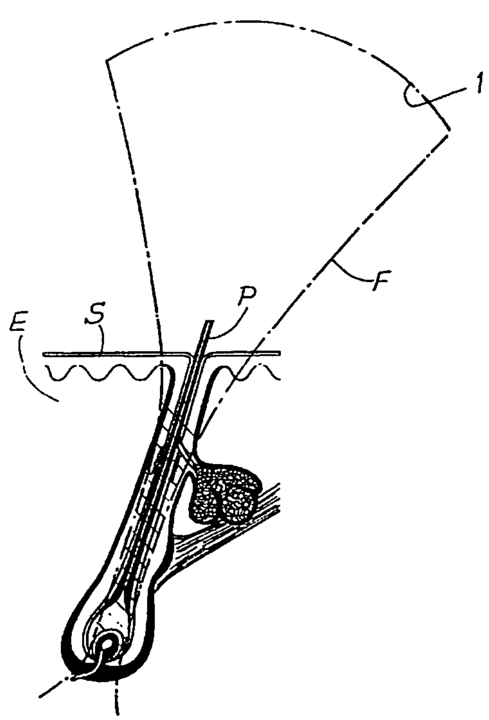
(54) Title: METHOD AND DEVICE FOR EPILATION BY ULTRASOUND



(57) Abstract: A description is given of a method of hair removal, characterized in that ultrasonic waves (F) are applied to a hair follicle until a rise in temperature is caused as a result of the absorption of said ultrasonic waves by the tissues, this temperature rise being sufficient to cause damage to the hair follicle.

WO 02/09813 A1

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Method and device for epilation by ultrasound

DESCRIPTION

Technical field

The present invention relates to an epilation method and a device for the application of said method.

Prior art

At the present time, techniques for removing superfluous hair are not only applicable to women with problems of hirsutism or hypertrichosis, but are commonly used on subjects of both sexes, not necessarily because they are suffering from particular pathologies, but purely for aesthetic reasons. The processes commonly used for this purpose can be classified in terms of the permanence of the results.

Thus there are short-term systems (such as razors, tweezers, hot and cold waxing, creams, gels and electric hair removers) and long-term systems which can sometimes yield permanent results after a certain number of sessions. Some examples of methods and devices relating to this second group of epilation techniques are needle-type electrocoagulators, needles with radio knives, non-coherent light and lasers.

Among the long-term treatment methods, the greatest success has been achieved by the use of laser systems which are based on the theory of selective photothermolysis and are able to damage the hair bulb by means of the laser energy absorbed by the melanin present in the hair or by the hemoglobin in the bulb blood vessels, in a ratio which depends on the wavelength of the laser used. This method is described in Anderson R., Parrish J: "The optics of human skin", J. Invest. Dermatol. 1981, 77:13-19, and in Parrish J., Anderson R. et al.: "Selective thermal effect with pulsed irradiation from lasers: from organ to organelle", J. Invest. Dermatol. 1983, 80:75s-80s;

In spite of the excellent results, limitations of this epilation treatment are encountered in the treatment of subjects with white hair or dark skin. In the first case, the hairs have a low melanin content, making the absorption of the laser radiation by the hair very limited, and therefore it is not

possible to make a significant contribution to the raising of the temperature of the hair bulb and thus damage it. In the second case, on the other hand, practically all of the radiation is absorbed by the skin (which, being dark, has a high melanin content) with the possibility of causing potentially irreversible damage to the subject's skin.

Laser epilation systems are more effective when they are applied to the hair in the anagen growth phase. This is because hair growth is not continuous but cyclical: a resting period, known as telogen, follows each growing period known as anagen; the period of transition between the two phases is known as catagen. The length of the cycle varies between areas of hair growth, from 2-6 years for the head hair to only 4-8 weeks for the eyebrows. According to current biological models, the cells which generate the follicle are located in what is known as the bulge area. These cells form the new matrix of the hair, thus initiating the growth phase. At the start of this phase, when the follicle is shorter, the papilla is closer to the skin surface; subsequently it extends to a greater depth and proliferates for a period varying according to the anatomical location. It is in the initial phase of anagen, or anagen 1, that the "target" structures of the follicle (such as the papilla and the bulge area), with their vascular system, are closer to the hair and to the surface of the epidermis; the closer the papilla and the tip of the hair, the greater is the probability that the laser energy absorbed by the melanin of the hair, and that arriving directly, will succeed in irreparably damaging the papilla, thus permanently blocking its capacity to make a hair grow. This shows clearly why the action of a laser is more effective in the anagen phase.

Objects and brief description of the invention

The object of the present invention is to provide a method and a device for long-term epilation which have a high efficacy and are not affected by the limitations of laser systems. More particularly, the object of the present invention is to provide a device and a method which can be used effectively even on subjects having a skin with a high melanin content and/or on subjects with white hair. A further object is to provide a method and a device whose efficacy is independent of the growing phase of the hair.

These objects are achieved, according to the present invention, by the use of an energy source which is not affected by the color of the hair or that of the skin: namely mechanical energy carried by ultrasonic waves.

These and other objects and advantages, which the following text will make clear to those skilled in the art, are obtained according to the present invention by means of an apparatus and a treatment method which use ultrasounds as the energy source for the removal of superfluous hairs.

The method according to the invention is thus characterized in that an area from which hair is to be removed is struck with ultrasonic waves until the temperature of the tissues is raised - as a result of the absorption of the energy carried by the ultrasonic wave - to a degree sufficient to cause damage to the hair follicle.

The term "ultrasounds" denotes a particular type of elastic mechanical waves (ultrasound or ultrasonic waves), characterized by a frequency of more than 20 kHz. These are successive waves of rarefaction and compression of the particles of each medium through which the waves pass, which are propagated longitudinally within the medium. The displacement of each particle of the medium within which the ultrasonic wave is transmitted is of the order of very small fractions of a millimeter, while the perturbation extends for several centimeters into the medium.

Ultrasonic waves can advantageously be generated by exploiting the phenomenon of piezoelectricity, a characteristic of certain materials such as quartz, barium titanate, lead titanate zirconate or polymers such as polyvinyl fluoride. The application of a potential difference to the ends of a plate made from these materials causes a dimensional change in the plate (the inverse piezoelectric effect). The frequency at which a plate of these materials, called a transducer, starts to vibrate when it is activated by a potential difference is called the resonant frequency, and is typically related to the thickness of the plate.

The width of a beam of ultrasonic waves is a function of the size of the transducer, the frequency, the material in which the propagation takes place, and the focusing of the beam. The last of the three cited parameters is

the most important. There are different ways of focusing an ultrasound beam: the use of an intrinsically focused plate, the interposition of acoustic lenses between the surface of the transducer and the tissues, and electronic focusing. All these procedures tend to achieve the same result of making the beam converge toward an area of space located at a certain desired distance from the interface between the ultrasonic transducer and the propagation medium of the ultrasonic waves.

In the case of the application to which the present invention relates, it is advantageous to arrange for the ultrasonic beam to be focused at a suitably selected depth with respect to the external surface of the skin, so that at this level (the focal plane) the diameter of the beam is as small as possible. This makes it possible to achieve a high density of energy carried by the ultrasonic waves and to strike with this energy only the desired target, in other words the tissues surrounding the hair follicle which is to be destroyed.

The intensity of the ultrasonic beam decreases progressively as it advances into the tissues. The phenomenon is closely dependent on the frequency of the beam in question, and is due to four different factors: reflection, diffusion, widening of the beam and absorption. The factor most relevant to the present invention is the phenomenon of energy absorption by the tissues through which the beam passes, with a conversion of the beam to heat and a consequent increase in temperature in the treated area. When the temperature of the soft tissue reaches approximately 65°C, the phenomenon known as protein denaturing occurs, with consequent necrosis of the tissue. This principle is used to carry out transcutaneous surgical operations (for literature on this subject, see: "Acoustic parameters of high energy pulsed ultrasound (hepus) for experimental tissue destruction", by T. Dreyer, J. Zenk, R. Rieldinger, T. Schneider, H. Iro, Ultrasound in Medicine and Biology, April 2000, 26(4) suppl B, PHO03; "Noninvasive monitoring of temperature distribution in the target field of hypertrhermia by ultrasonic tissue characterization" by L. Zuna, P. Novak, L. Pousek, P. Schreib, P. Pesche, A. Lorenz, J. Debus, Ultrasound in Medicine and Biology, April 2000, 26(4) suppl B, PHO04; "Acoustic parameters of high energy pulsed ultrasound (hepus) for

experimental tissue destruction" by T. Dreyer, J. Zenk, R. Rieldinger, T. Schneider, H. Iro, Ultrasound in Medicine and Biology, April 2000, 26(4) suppl B, PHO03; "Treatment of uterine fibroid tumors in eker rats using high intensità focused ultrasound" by S. Vaezy, M. Paun, P. Nelson, C. Walzer, V. Fujimoto, Ultrasound in Medicine and Biology, April 2000, 26(4) suppl B, PHO05; "A new treatment for miu controlled hifu therapy", by J. Jehne, R. Rastert, L. Simiantonakis, C. Bohris, J. Spoo, J. Debus, Ultrasound in Medicine and Biology, April 2000, 26(4) suppl B, PHO06).

In practice, according to the invention, use can be made of a transducer emitting ultrasonic waves capable of focusing the beam (or a transducer provided with auxiliary means of focusing the beam) in a precise and limited area of space. Advantageously, the focal zone of the beam has a pseudo-cylindrical shape with a circular directrix and segments on the generatrices having dimensions a few times greater than the diameter of the circle subtended by the directrix.

By using frequencies in the range from a few hundred kHz to a few MHz, and typically from 100 kHz to 10 MHz, it is possible to obtain a focal spot with lateral dimensions which may be up to a few tenths of the millimeter and a longitudinal extension which may be a few millimeters. A sufficient ultrasonic energy creates a necrosis in a "carrot"-shaped volume of tissue which comprises the hair follicle. Because the volume affected by the raising of the temperature is small, the necrosis of the follicle can be achieved with minimal damage, or none at all, to the surrounding tissues.

The small dimensions of the focal spot make it appropriate to use optical magnifying systems which enable the operator to emit the ultrasonic energy when the hair and the surrounding structures have been identified by means of a suitable aiming system. The use of a relatively long focal zone means that a lack of knowledge of the depth at which the hair is located is "not critical".

Further advantageous characteristics and embodiments of the method according to the invention are indicated in the attached claims.

The invention also relates to an epilation device characterized in

that it has a focused ultrasonic beam generator. The ultrasonic generator can consist of an ultrasonic transducer, for example an intrinsically focused transducer, or an array of transducers. Alternatively, the generator can comprise an ultrasonic transducer and other components, for example focusing means, which in combination with the transducer generate a focused beam.

A different way of constructing the ultrasonic generator requires the use of a fiber which is brought into position and through which a Q-switched laser radiation is transmitted, creating a mechanical shock and thus giving rise to an ultrasonic wave. A transducer of this type is described in IT-A-1286836 and in further bibliographical references cited therein.

To obtain correct acoustic coupling, the transducer can be combined with a low-impedance means, for example a bag containing a gel or a liquid, for example water, which is interposed between the transducer and the epidermis. This bag and the substance contained in it can advantageously be transparent or translucent to permit observation of the area to be treated.

The device can also be combined with magnifying means to facilitate the observation of the area to be treated, for example a micro-video camera or bundles of coherent fibers, connected to a monitor. To facilitate the use of the device, it can be provided with suitable aiming means, for example an aiming beam, which can be an optical beam of white or colored light, or preferably a laser beam which can be guided toward the operating area by means of a light guide consisting of optical fiber or equivalent.

In a particularly advantageous embodiment of the device, means can be provided to cool the area subjected to the epilation treatment, with the double purpose of causing the erection of the hair to facilitate its destruction by means of the acoustic beam, and preventing heat damage or disagreeable sensations of excessive heating due to the high energy density incident on the tissues. The cooling means can consist of cold air blowing systems or possibly a system of cooling the substance contained in the bag, provided for the purpose of acoustic coupling, positioned between the ultrasonic transducer and the epidermis. It is also possible to include in the handpiece a

small LCD monitor, of the type used in modern amateur video cameras, to be connected to the micro-video camera or to the bundle of coherent fibers, thus making it possible to view the portion of skin to be treated. If the user considers it more convenient, it is always possible to use an external monitor (of the TV screen type) in place of the LCD type fitted on the handpiece.

The ultrasonic generator, the bag containing the substance for acoustic coupling, and any aiming and observation systems can be fitted in a handpiece which can easily be grasped by the operator.

Further possible advantageous characteristics of the device according to the invention are indicated in the attached claims.

Brief description of the drawings

The invention will be more clearly understood from the description and the attached drawing which shows non-restrictive practical embodiments of the invention. In particular, in the drawing:

Fig. 1 shows the anatomical structure of the hair follicle and the operating principle of the system and method according to the invention;

Fig. 2 shows schematically a different procedure for obtaining a focused ultrasonic beam;

Fig. 3 shows schematically a longitudinal section through a handpiece for the application of the method according to the present invention; and

Fig. 4 shows a front view according to IV-IV in Fig. 3.

Detailed description of an embodiment of the invention

Fig. 1 shows schematically the principle on which the present invention is based. This figure shows a portion of epidermis E, whose external surface is indicated by S. P indicates a hair to be removed, with the corresponding follicle and the other anatomical structures, including the sebaceous gland and the erector muscle.

An ultrasonic transducer, for which the emission surface of the wave front is indicated in a general way by 1, generates a focused ultrasonic beam F which has a focused zone of pseudo-cylindrical form under the surface S of the epidermis. The volume of this pseudo-cylindrical zone

encloses the follicle of the hair P. Downstream from the follicle with respect to the direction of arrival of the wave front, the beam F widens.

In order to obtain the focusing of the ultrasonic beam, the transducer can be intrinsically focused, being in the shape of a portion of a hollow spherical bowl, as indicated schematically by the surface 1 in Fig. 1. However, this is not the only possible focusing method. Alternatively, a flat transducer with an acoustic lens which enables the beam to be focused (not illustrated) can be used. In a different embodiment, electronic focusing systems are used, which enables the distance of the focal spot to be varied as required.

Another possible embodiment, shown schematically in Fig. 2, makes use of a system formed by an array of ultrasonic transducers in the form of concentric rings, indicated schematically by 5A, 5B in Fig. 2. These transducers are aligned in phase, thus enabling the size of the lateral emission lobes (lobes L1 in Fig. 2) to be minimized, while the central emission lobes L2 are added to obtain focal spots which are very restricted laterally and cover a sufficient depth.

Regardless of the chosen focusing methods, by suitable design of the emitting surface of the transducer or of the array of transducers (which must have rather large dimensions, of the order of a few centimeters for example), and by using frequencies in the range from a few hundred kHz to several MHz, it is possible to focus the beam of ultrasound, thus providing a focal spot with a width of a few tenths of a millimeter and a length which may be a few millimeters, to cover a wide range of depths. The form of the ultrasonic beam will be such that the energy density in the surface region S of the skin (where the beam enters the tissues) will be low, while in the depth of the focal zone the energy density will be high. The ultrasound system which has been constructed produces a temperature rise in the tissues, due to their absorption of the ultrasound and the consequent conversion of the mechanical energy to thermal energy. When the temperature of approximately 65°C has been reached in the soft tissue, the process of protein denaturing starts and results in the necrosis of the tissue. If sufficient ultrasonic energy is

used, a "carrot"-shaped necrosis is created in a volume of tissue extending from the epidermis and including the whole structure of the hair follicle, the papilla and the bulge area. Because the volume concerned is small, local hyperthermia can be obtained in a very small volume, restricted to the hair follicle alone, thus limiting, or even eliminating, any irreversible damage to the surrounding tissues.

During the various phases of growth of the hair, the position of the papilla and the bulge area vary within a range of several mm. The longitudinal dimension of the "carrot"-shaped volume within which the ultrasonic beam is focused is such that these structures are struck in all of their possible positions, so that the efficacy of the treatment no longer depends, as in the case of laser epilation, on the closeness of the papilla to the tip of the hair. The result can therefore be permanent, even if the hair is not in the anagen phase.

Figs. 3 and 4 show schematically an embodiment of an epilation device according to the invention. The device comprises a handpiece, indicated in a general way by 11, in which the ultrasonic transducer indicated by 13 is located. In this embodiment, the transducer is an intrinsically focused transducer, with an emission surface in the form of a concave spherical bowl, as shown schematically in Fig. 1.

The handpiece 11 is provided with a spacer 15, by means of which the focal zone of the ultrasonic beam is positioned at a short distance below the surface S of the skin (as shown in the diagram in Fig. 1), where the hair follicle is located. To facilitate the aiming of the ultrasonic beam, the handpiece 11 is associated with a light guide formed by a very low power laser 17 and an optical fiber 19 whose remote end opens approximately in the center of the spherical bowl forming the emission surface of the transducer 13. Thus a spot of light corresponding to the point of intersection of the axis of the focused ultrasonic beam is projected on to the surface S of the epidermis.

The handpiece is also associated with a micro-video camera 21, connected to a monitor 23, for displaying the skin which is to be treated, in such a way that the ultrasonic energy is released precisely at the position of a

hair follicle, with the aid of the aiming system consisting of the laser 17 and the corresponding optical fiber 19. A light source 25 generates a beam of illumination of the area to be viewed, for correct operation of the micro-video camera 21. The light generated by the source 25 is guided to the treatment area by means of a light guide 27 of the optical fiber type or the like.

The handpiece is provided with a bag 29 of flexible material, arranged so that it is located, during operation, between the transducer 13 and the skin. The bag 29, made from flexible and transparent or translucent material, contains water or a similar transparent substance which does not attenuate the ultrasounds, to provide an acoustic coupling between the ultrasonic transducer 13 and the skin on which the treatment is to be carried out. The presence of this bag makes it possible to have an optimal distance between the transducer and skin for the correct positioning of the focal zone below the skin. It should be noted that air markedly attenuates ultrasounds, so that it becomes important to use a means which reduces the coefficient of attenuation of the region lying between the transducer and the skin. The means used must be transparent to permit the operation of the optical magnifying systems (micro-video camera 21 and monitor 23 in the illustrated example) and of the aiming laser 17.

To further improve the transmission of ultrasounds while reducing the coefficient of attenuation of the means through which the ultrasonic waves are to pass, it is possible to arrange for a thin layer of transparent gel to be interposed between the bag 29 and the skin. Alternatively, the skin can be lightly bathed before the ultrasonic handpiece is passed over it.

To prevent the temperature rise produced by the ultrasonic impulse from causing pain or discomfort in the subject being treated, it is possible to use a skin cooling system of the cold air emission type during the treatment. By using a cooling system it is also possible to make the erector muscles of the hair contract, so that the hair is brought into a more perpendicular position with respect to the skin surface. In this condition, it is easier to position the focused zone of the ultrasonic beam correctly in such a way that all the relevant areas (follicle, papilla and bulge area) are struck. Cooling of the cold

air type is particularly useful where the substance contained in the bag 29 has a gelatinous consistency.

A different possible method of cooling the skin, which is particularly advantageous if the substance contained in the bag is very fluid (water, for example), consists in providing a system for directly cooling the substance contained in the bag 29. The contact of the external surface of the bag 29 with the surface layer of the skin cools the skin and causes the contraction of the erector muscles of the hair. A solution of this type is shown in the example illustrated in Figs. 3 and 4. The liquid in the bag 29 is guided by means of ducts 31 toward a heat exchanger 33 where there is provided an arrangement of tubes in which a fluid refrigerated by an external refrigerator unit 35 circulates, or a different arrangement for obtaining the forced cooling of the liquid in the bag 29.

As an alternative to the cooling system, when it is not necessary to provide cooling to prevent the risk of burns, it is possible to use any method which achieves the object of making the erector muscles of the skin contract.

The device indicated schematically in Figs. 3 and 4 is supplemented by a unit 37 for supplying and controlling the transducer 13.

Epilation is carried out as follows: the handpiece is grasped by the operator and brought with the bag 29 into contact with the skin of the subject to be treated, in the proximity of the individual hair to be removed. The bag is pressed against the external surface of the skin and the operator observes on the monitor 23 the area under the transducer 13 recorded by the micro-video camera 21. The spot of the aiming laser beam generated by the source 25, as well as the hair to be removed, will be visible in this area. The handpiece can thus be positioned by the operator so that the axis of the ultrasonic transducer 13 is made to intercept the skin at the position of the follicle, the interception point coinciding with a good approximation with the spot of the aiming laser beam. When the aiming has been carried out in this way, the ultrasonic transducer 13 is operated, for example by means of a push button on the handpiece 11 (not shown) or by means of a pedal control or other. The acoustic energy generated in this way is focused around the hair follicle, and

the temperature of the tissues struck by the focused zone (which has a "carrot"-like or pseudo-cylindrical shape, as indicated above) is brought to a value sufficient to cause their necrosis.

The process is repeated for all the hairs which are to be removed.

Without restriction to specific values, which can vary from one case to another and which can easily be identified by the operator by a series of tests, pulses of ultrasonic waves suitable for destroying the hair follicle typically have the following characteristics: an acoustic energy per pulse in the range from 100 to 1200 mJ, and preferably from 120 to 250 mJ; and a pulse length in the range from 15 to 200 ms, and preferably from 20 to 40 ms.

The beam is advantageously focused in such a way as to generate a focusing zone with a maximum transverse dimension of the order of 1 mm or preferably of the order of 0.5 mm or less, and with a longitudinal dimension of the order of 1-8 mm and preferably of the order of 2-4 mm.

It is to be understood that the drawing shows only an example provided solely as a practical demonstration of the invention, this invention being variable in its forms and arrangements without departure from the scope of the guiding principle of the invention. The presence of any reference numbers in the attached claims is intended to facilitate the reading of the claims with reference to the description and to the drawing, and does not limit the scope of protection represented by the claims.

CLAIMS

1. An epilation method, characterized in that ultrasonic waves are applied to a hair follicle until a rise in temperature is caused as a result of the absorption of said ultrasonic waves by the tissues, this temperature rise being sufficient to cause damage to the hair follicle.

2. The method as claimed in claim 1, characterized in that a beam of ultrasound is generated and said beam is focused in the area surrounding the hair follicle.

3. The method as claimed in claim 1 or 2, characterized by applying an ultrasonic energy capable of raising the temperature of the tissues of the hair follicle to a temperature equal to or greater than the temperature at which the proteins of said tissues are denatured.

4. The method as claimed in claim 3, characterized in that the temperature of said tissues is raised above 60°C and preferably to approximately 65°C.

5. The method as claimed in one or more of the preceding claims, characterized in that a focusing volume of the ultrasonic beam is generated with an elongate shape which penetrates from the skin surface toward the interior of the underlying tissues, the area of greater energy density of the focused ultrasonic beam being under the skin surface.

6. The method as claimed in one or more of the preceding claims, characterized in that the ultrasonic beam is focused in a volume having a transverse dimension of less than 1 mm and preferably equal to or less than 0.5 mm.

7. The method as claimed in one or more of the preceding claims, characterized in that the ultrasonic beam is focused in a volume having a longitudinal dimension in the range from 1 to 8 mm and preferably in the range from 2 to 4 mm.

8. The method as claimed in one or more of the preceding claims, characterized in that an acoustic coupling liquid is interposed between an ultrasonic transducer and the skin to be treated.

9. The method as claimed in claim 8, characterized in that said

acoustic coupling liquid is placed in a transparent bag, said liquid also being transparent.

10. The method as claimed in one or more of the preceding claims, characterized by the steps of:

- using an optical aiming beam to orient an ultrasonic transducer toward an area of skin to be treated;

- generating an ultrasonic acoustic beam by means of said transducer, focused under the skin surface of the area of skin to be treated.

11. The method as claimed in claim 10, characterized in that the area of skin to be treated is observed through an optical magnifying means.

12. The method as claimed in one or more of the preceding claims, characterized in that the area of skin to be treated is superficially cooled.

13. The method as claimed in one or more of the preceding claims, characterized in that the ultrasonic beam has a frequency in the range from 100 kHz to 10 Mhz.

14. The method as claimed in one or more of the preceding claims, characterized in that said acoustic beam is a pulsed acoustic beam having an acoustic energy per pulse in the range from 100 to 1200 mJ and preferably from 120 to 250 mJ.

15. The method as claimed in claim 14, characterized in that said pulses have a length in the range from 15 to 200 ms and preferably from 20 to 40 ms.

16. An epilation device characterized in that it comprises at least one generator of a focused ultrasonic beam.

17. The device as claimed in claim 16, characterized in that said focused ultrasonic beam has a power sufficient to cause the necrosis of the tissues struck by said beam.

18. The device as claimed in claim 16 or 17, characterized in that said generator comprises at least one intrinsically focused ultrasonic transducer.

19. The device as claimed in claim 16 or 17, characterized in that said ultrasonic generator comprises an array of ultrasonic transducers in the form of concentric rings.

20. The device as claimed in claim 16 or 17, characterized in that said ultrasonic generator comprises an ultrasonic transducer and focusing means.

21. The device as claimed in one or more of claims 16 to 20, characterized in that it comprises a handpiece on which said ultrasonic generator is located.

22. The device as claimed in claim 21, characterized in that said handpiece comprises a spacer element to keep said generator at the correct distance from the skin of a subject being given the epilation treatment, the focused zone of the acoustic beam being thus positioned in the volume of tissue underlying the skin surface and containing the hair follicle to be removed.

23. The device as claimed in one or more of claims 16 to 22, characterized by a bag containing an acoustic coupling liquid.

24. The device as claimed in claim 23, characterized in that said bag and said acoustic coupling liquid are transparent.

25. The device as claimed in one or more of claims 16 to 24, characterized in that the ultrasonic generator generates a beam focused in a volume with a transverse dimension equal to or less than 1 mm and preferably equal to or less than 0.5 mm.

26. The device as claimed in one or more of claims 16 to 25, characterized in that the ultrasonic beam generator generates a beam focused in a volume having a longitudinal *p+6Xdimension in the range from 1 to 8 mm and preferably in the range from 2 to 4 mm.

27. The device as claimed in one or more of claims 16 to 26, characterized in that it comprises an optical aiming system.

28. The device as claimed in claim 27, characterized in that said optical aiming system comprises a low-power laser source.

29. The device as claimed in one or more of claims 16 to 28,

characterized in that it comprises a system for magnifying the skin area to be treated.

30. The device as claimed in claim 29, characterized in that said magnifying system comprises a lens for the direct observation of the skin area to be treated.

31. The device as claimed in claim 29, characterized in that said magnifying system comprises a micro-video camera.

32. The device as claimed in one or more of claims 16 to 31, characterized in that it comprises a system for cooling the skin area to be treated.

33. The device as claimed in claims 22 and 32, characterized in that said cooling system comprises means for cooling said acoustic coupling liquid.

34. The device as claimed in one or more of claims 16 to 33, characterized in that said generator emits an acoustic beam with a frequency in the range from 100 kHz to 10 MHz.

35. The device as claimed in one or more of claims 16 to 34, characterized in that said generator emits a pulsed acoustic beam with an effective acoustic energy per pulse in the range from 100 to 1200 mJ and preferably from 120 to 250° mJ per pulse.

36. The device as claimed in claim 35, characterized in that said generator emits pulses with a length in the range from 15 to 200 ms and preferably from 20 to 40 ms.

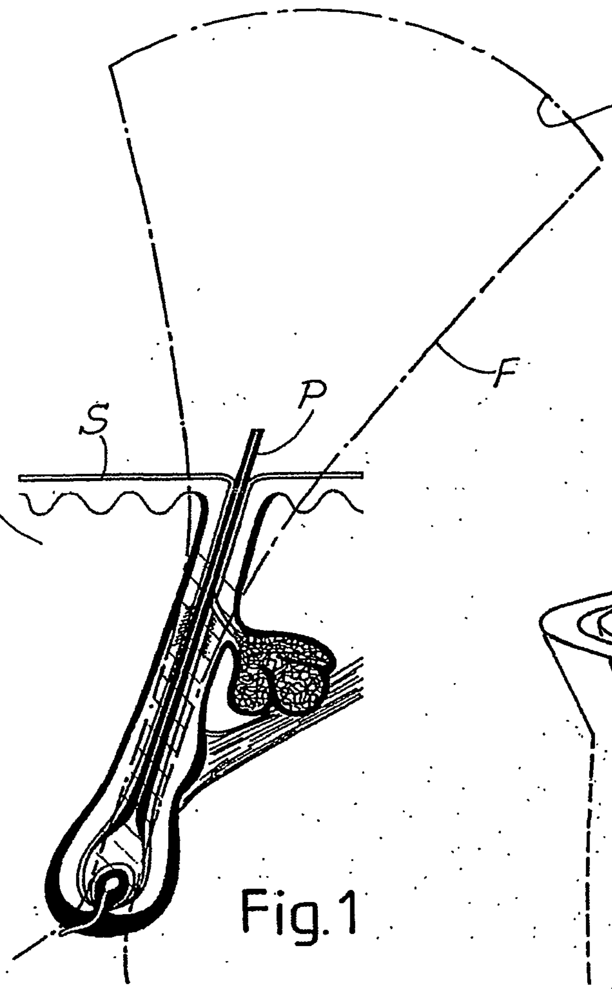

Fig.1

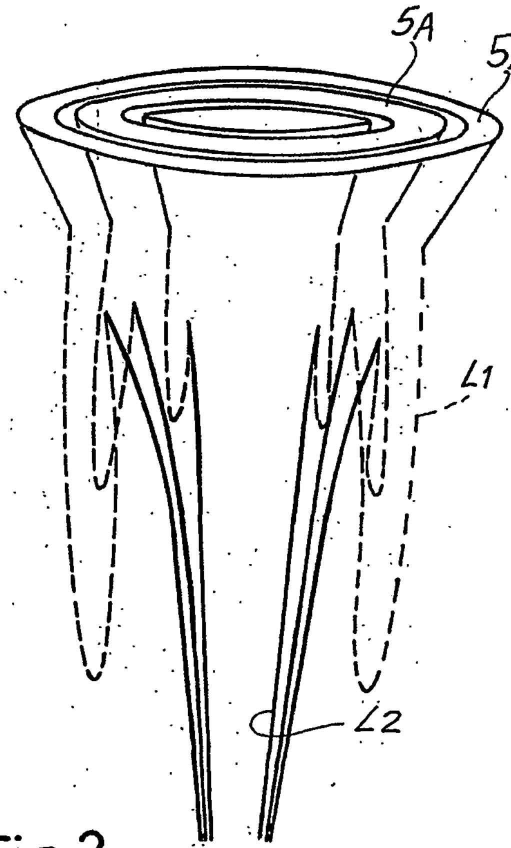

Fig.2

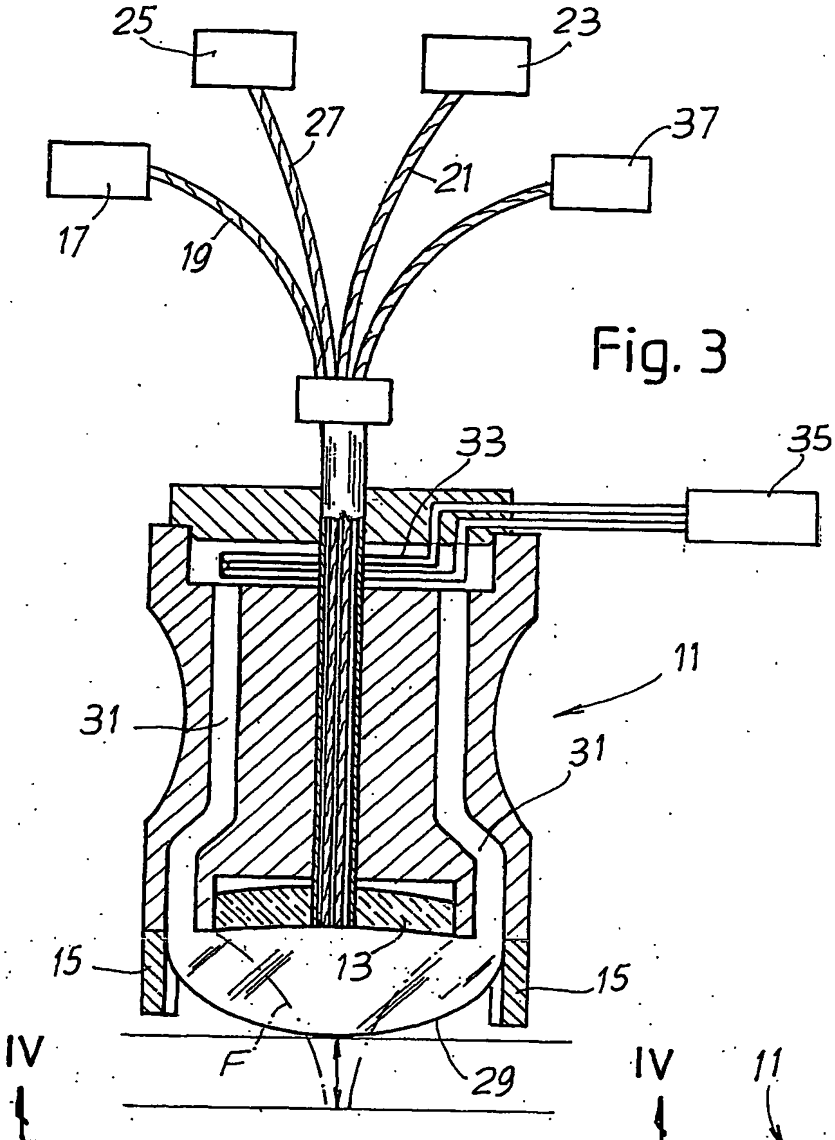
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Fig. 3

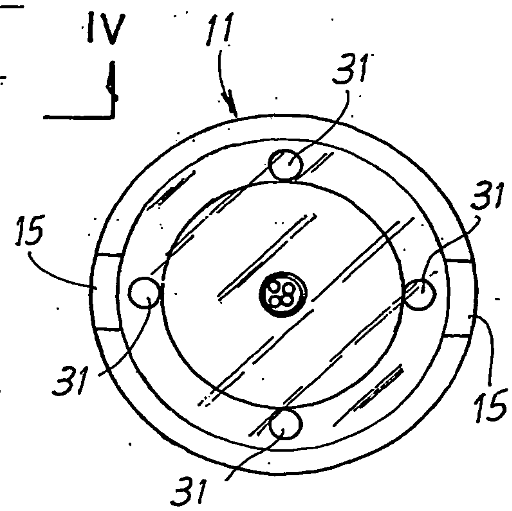
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Fig. 4

INTERNATIONAL SEARCH REPORT

ional Application No
PCT/IT 00/00324

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61N7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61N A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00 21612 A (IGER YONI ;SEGAL EMANUEL (IL); ELMAN DMITRY (IL); SHALHEVET DAVID) 20 April 2000 (2000-04-20)	1-8, 13-21, 25,26, 29,31, 34-36
Y	page 15, line 20 - line 27; figure 1; example 1	9,12, 22-24, 29,31-33
Y	US 4 556 070 A (MCEUEN ALBERT H ET AL) 3 December 1985 (1985-12-03) column 2, line 56 - line 61; figure 1	12,32,33
Y	US 4 646 756 A (HYNYNEN KULLEVRO ET AL) 3 March 1987 (1987-03-03) column 5, line 60 - line 62; figure 7	9,22-24
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 March 2001	28/03/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Mayer, E

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PCT/IT 00/00324

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	column 5, line 37 - line 47; figure 3	10,11, 27,28,30
A	US 5 628 744 A (DAVENPORT SCOTT A ET AL) 13 May 1997 (1997-05-13) abstract; figure 6	10,11

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